

Seraj, Mehdi; Coskuner, Cagay

Article

Real exchange rate effect on economic growth: Comparison of fundamental equilibrium exchange rate and Balassa-Samuelson based Rodrik approach

Journal of Applied Economics

Provided in Cooperation with:

University of CEMA, Buenos Aires

Suggested Citation: Seraj, Mehdi; Coskuner, Cagay (2021) : Real exchange rate effect on economic growth: Comparison of fundamental equilibrium exchange rate and Balassa-Samuelson based Rodrik approach, Journal of Applied Economics, ISSN 1667-6726, Taylor & Francis, Abingdon, Vol. 24, Iss. 1, pp. 541-554,
<https://doi.org/10.1080/15140326.2021.1977083>

This Version is available at:

<https://hdl.handle.net/10419/314144>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by/4.0/>



Real exchange rate effect on economic growth: comparison of fundamental equilibrium exchange rate and Balassa–Samuelson based Rodrik approach

Mehdi Seraj & Cagay Coskuner

To cite this article: Mehdi Seraj & Cagay Coskuner (2021) Real exchange rate effect on economic growth: comparison of fundamental equilibrium exchange rate and Balassa–Samuelson based Rodrik approach, Journal of Applied Economics, 24:1, 541-554, DOI: [10.1080/15140326.2021.1977083](https://doi.org/10.1080/15140326.2021.1977083)

To link to this article: <https://doi.org/10.1080/15140326.2021.1977083>



© 2021 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.



Published online: 27 Sep 2021.



Submit your article to this journal [↗](#)



Article views: 6187



View related articles [↗](#)



View Crossmark data [↗](#)



Citing articles: 4 View citing articles [↗](#)



OPEN ACCESS



Real exchange rate effect on economic growth: comparison of fundamental equilibrium exchange rate and Balassa–Samuelson based Rodrik approach

Mehdi Seraj^a and Cagay Coskuner^b

^aEconomics Department, Near East University, Nicosia, North Cyprus, Mersin 10, Turkey; ^bDepartment of Economics, Eastern Mediterranean University, Famagusta, North Cyprus, Mersin 10, Turkey

ABSTRACT

This study reproduces the work of Dani Rodrik on real exchange rate undervaluation and economic growth for 93 countries over the period 1990–2018. While the empirical literature on the dynamics between the real exchange rate¹ and economic growth is relatively comprehensive, little has been done to compare these dynamics within economies using the Balassa–Samuelson-based Rodrik approach (BS) and the fundamental equilibrium exchange rate model (FEER). This research, to the best of the authors' knowledge, is one of the first to compare the fundamental equilibrium exchange rate model and Balassa–Samuelson-based Rodrik approach and use dynamic estimation on the Rodrik approach. The findings of the study support Rodrik's conclusion that undervaluation has a significant impact on economic growth, although the results of FEER are more significant than those of BS. Furthermore, the first lag of undervaluation has a significant effect on economic growth.

ARTICLE HISTORY

Received 6 November 2020
Accepted 1 September 2021

KEYWORDS

Economic growth; exchange rate undervaluation; Balassa–Samuelson effect; fundamental equilibrium exchange rate model; Rodrik model

1. Introduction

Over the years, economists have come to agree that a poorly handled exchange rate does more harm than good to the growth effort of any economy. As pointed out by Rapetti (2020), mainstream economics considered real exchange rates irrelevant for economic growth performance in 1950s. This has changed in 1970s with the emergence of export-oriented growth strategies of East and Southeast Asian countries. When it was recognized that overvaluation of real exchange rates could hamper exports and thus growth, academics and policymakers have focused on equilibrium concept of real exchange rates. The pioneering work in the field was Balassa (1970). In the subsequent decades, a consensus – termed as Washington Consensus by Williamson (1990) – has emerged among the economist. This has recognized the equilibrium of real exchanges as a determinant of growth. In line, fundamental equilibrium of exchange rates (FEER) has been introduced based on both internal and external factors. Authors such as Dollar (1992), Sachs and Warner (1995), Ghura and Grennes (1993), and Cottani, Cavallo, and Khan (1990) have all supported the positive impact of RER equilibrium on growth.

CONTACT Mehdi Seraj  mehdi.seraj@neu.edu.tr  Economics Department, Near East University, Mersin, Turkey

© 2021 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Similarly, William Easterly (2003) argued that high overvaluation would have a negative impact on economic growth. However, he was skeptical that modest trending in the exchange rate would have a determinate impact on economic growth.

However, another cornerstone study came in 2008 by Rodrik. Rodrik (2008) departed from the consensus as it concluded that a disequilibrium – an undervaluation of real exchange rate – was contributing to growth. This has intensified the interest on research studying the role of real exchange rates on economic growth. This paper is in line with these recent literatures. More specifically it aims to investigate if an undervaluation of real exchange rate – a disequilibrium – has a positive impact on growth.

To do so, this study uses Rodrik's (2008) paper, "The real exchange rate and economic growth," as a benchmark to carry out a panel data analysis of the impact of currency undervaluation on economic growth. The data includes 93 countries over the period of 1990–2018. We use both Balassa-Samuelson-based Rodrik approach (BS) and the fundamental equilibrium exchange rate (FEER)-based approach to estimate the misalignment measure – Undervaluation -. Then we use this measurement as an explanatory variable in a standard growth study.

We intend to contribute to the literature on two folds: First, we use a dynamic econometric estimation technique – GMM – hence get a better estimation result. To the best of our knowledge, this paper is one of the first to use the dynamic estimation approach in this field. Second, we include lags of currency undervaluation as explanatory variables. There is only one study who did this before, and this is Razmi, Rapetti, and Skott (2012).

This article is organized into seven sections. Section one gives the introductory background, section two covers the literature review, sections three and four explain the Balassa-Samuelson effect and fundamental equilibrium exchange rate model, section five involves data and methodology, section six displays the empirical results, and section seven shows the conclusion of this research.

2. Literature review

Looking at the issue from both angles, Rodrik (2008) conclusion is that although overvaluation damages growth, undervaluation smooths it. Recently, international trade has been very difficult and more influential than the so-called barter trade. Nowadays, foreign transactions and trade are related and cannot be carried out without considering currency stability, economic stability/prosperity, and political stability. Currency instability has historically had a significant influence on both domestic economies and foreign trade. Therefore, an increasing number of researchers in these fields of study have moved their attention towards foreign exchange rates. Much of the current research has shifted its interest to the effect of the real exchange rate on economic growth and the different ways to calculate the undervaluation.

Rodrik (2008) examined the relationship between the real exchange rate and economic growth. He found that a positive relationship exists between real exchange rate undervaluation and growth and asserted that this relationship is more pronounced in developing countries. The instability of the real exchange rate from its equilibrium can have either a positive or negative effect on economic growth. In order to explore and investigate the equilibrium exchange rate in-depth, several researchers have used various

terms, such as exchange rate misalignment, to describe the changes in the real exchange rate. Exchange rate misalignment simply describes the fluctuation of the real exchange rate from its equilibrium level. Rapetti (2020) estimated the effect of real exchange rate volatility on economic growth and found a positive relationship between them, especially in developing countries. He also mentioned that overvaluation is harmful to economic growth and real exchange rate volatility has a negative effect on growth. Habib, Mileva, and Stracca (2017) found the same results and confirmed that real exchange rate depreciation rises the annual GDP growth in developing countries and real exchange rate appreciation decreases the GDP growth. Meanwhile, Ybrayev (2021) claimed that there is a positive linkage between real exchange rate undervaluation and growth of manufacturing exports and high-tech manufacturing industries, but RER overvaluation increases the growth rate in primary products industries.

Tharakan (1999) and Vieira, Holland, Gomes da Silva, and Bottecchia (2013) posited that a highly misaligned exchange rate would have an adverse effect on economic growth, while an average misaligned exchange rate would have a positive effect on economic growth. Undervaluation or overvaluation of currency is usually associated with emerging economies. However, when a currency is heavily depreciated or below what is expected, we term this to be exchange rate undervaluation. Overvaluation is the reverse. It is a situation in which the exchange rate of one currency to another currency is very much higher than it is expected to be or when a currency is seriously appreciated. Undervaluation of exchange rates has been found to have positive effects on economic growth (Abida, 2011; Rodrik, 2008), while overvaluation of exchange rate reduces economic growth (Elbadawi, Kaltani, & Soto, 2012). However, in their investigation of the impact of exchange rate undervaluation on selected macroeconomics variables, Gluzmann, Levy-Yeyati, and Sturzenegger (2012) discovered that currency undervaluation in developing countries has no impact on exportation; rather, it enhances saving, investment, and employment opportunities.

In their analysis of the relationship between real exchange rate and GDP per capita, Cottani et al. (1990) found an inverse relationship between GDP per-capita growth and the real exchange rate. They carried out an investigation on two forms of the real exchange rate – real exchange rate misalignment and real exchange rate instability – and discovered an insignificant relationship between economic growth and the PPP exchange rate. In the same vein, Dollar (1992) found that a negative relationship exists between GDP per capita and the distortion in the exchange rate, after controlling for the impact of variability in the exchange rate and investment level. In their analysis, Berg and Miao (2010) discovered some loopholes in Rodrik's (2008) research, arguing that an identification problem exists in Rodrik's model. According to Berg and Miao (2010), some factors determine misalignment and also affect economic growth. While Rodrik perceived undervaluation to be good and overvaluation to be bad, the Washington Consensus had a different view. They considered undervaluation and overvaluation to be inappropriate for growth stimulation. Although Berg and Miao (2010) supported Rodrik's (2008) findings on undervaluation and overvaluation, after controlling for certain variables, shows that real exchange rate undervaluation from PPP values as investigated by Rodrik (2008), cannot explain the impact on long-term growth. However, in the analysis on the Washington Consensus, the variation from the real exchange rate fundamental was found to explain long-term growth.

Eichengreen (2008) investigated the impact of the real exchange rate on economic growth and the link between these variables. He posited that although there is a link through which competitive real exchange rate influences growth, this link is not overwhelming. However, the study did not identify the crucial link of transmission.

Some studies have linked undervaluation of the exchange rate to economic growth through enhancement of saving, i.e., domestic saving. Levy-Yeyati and Sturzenegger (2007) argued that undervaluation of the exchange rate is related to lower real wages and enhanced higher savings, thereby stimulating investment. Montiel and Servén (2008) pointed out that the relationship between saving and the real exchange rate is empirically and theoretically weak. They found no support for the positive relationship between higher saving rates and a depreciated currency.

3. Balassa-Samuelson effect

As mentioned before, this paper uses two different measures of real exchange rate equilibrium, and thus two different measures for currency undervaluation. The first one is Rodrik (2008) approach based on Balassa-Samuelson model. The second one is FEER suggested in Washington Consensus. Let us then, brief on what exactly Balassa-Samuelson model is in this section.

In the Balassa-Samuelson model, the relative price of non-tradable, and thus, the real exchange rate movements, depends on the relative productivity growth rate in the traded and nontraded sectors.

In a small open economy, where the price of tradables is fixed at world prices, higher productivity growth in the tradable sector leads to higher wages both in tradable and non-tradable sectors since the labor is mobile across the sectors. However, higher wages in the non-tradable, without a corresponding higher productivity in the sector, lead to higher relative prices for non-tradable. This, in turn, leads to an appreciation of the home currency.

Balassa-Samuelson effect then states that as countries achieve rapid productivity growth in tradable sectors, transitioning them from a lower-income to higher-income status, their prices of non-tradable increase and their currencies appreciate. Hence higher-income countries are expected to have more appreciated currencies. Like Rodrik (2008), we use this conclusion to determine our equilibrium level of real exchange rate.

The validity of the Balassa-Samuelson (BS) theorem is investigated extensively in the international economics literature. For example, Berka and Devereux (2010) discover that the movements in the RER and the domestic relative prices of non-traded goods are extraordinarily correlated. Berka et al. (2014) also study the Balassa-Samuelson effect for a set of European countries. They understood that productivity increases in the tradable sector relative to the non-tradable sector have a positive relationship with RER appreciations. Zhang (2017) also finds that there is a positive link between a country's per capita income and its home price level.

4. Fundamental equilibrium exchange rate model (FEER)

FEER was first introduced by Williamson (1994), and it intended to measure the equilibrium level of real exchange rate based on achieving both the internal and external balances (Rapetti, 2020). Thus, FEER models included variables such as terms of trade,

degree of trade openness, productivity, investment, government consumption and stock of net international assets. (Hinkle and Montiel 1999). In line with this, Berg and Miao (2010) suggest that Rodrik's estimation of RER equilibrium is not sufficiently reliable because of some important missing variables. Hence, Berg and Miao (2010) used the FEER model in accordance with the Washington Consensus by adding terms of trade, trade openness, government consumption, and investment variables to real GDP per capita (the BS effect) in estimating an effective real exchange rate undervaluation.

We also used FEER as mentioned in the Washington Consensus to do the same. Thus, we try to create two alternative estimates of exchange rate undervaluation. $UNDerval^{BS}$ follows exactly Rodrik (2008) and measures the real exchange rate undervaluation from PPP, adjusted for real GDP per capita. $UNDerval^{FEER}$ follows the Washington Consensus concept and uses the additional control variables beyond the GDP per capita to estimate the real exchange rate, such as terms of trade, trade openness, investment, and government consumption.

5. Data and methodology

5.1. Empirical specifications

As mentioned earlier, the purpose of this chapter is to improve on the original work of Rodrik (2008) on several dimensions. To this end, we make use of the following models:

First of all, the equilibrium level of the real exchange rate is estimated in two different ways:

One is the based-on Balassa-Samuelson effect only, as in original Rodrik (2008),

$$\ln(\widehat{RER})_{it} = \alpha_0 + \alpha_1 \ln(RGDPPC)_{it} + f_t + e_{it} \quad \text{eq1}$$

The second one is the FEER model which is presented in eq 2,

$$\begin{aligned} \ln(\widehat{RER})_{it} = & \beta_0 + \beta_1 \ln(RGDPPC)_{it} + \beta_2 \ln(TOT)_{it} + \beta_3 OPEN_{it} + \beta_4 GOVT_{it} \\ & + \beta_5 INVT_{it} + f_t + e_{it} \end{aligned} \quad \text{eq2}$$

where $RGDPPC$ stands for real GDP per capita, TOT stands for terms of trade, $OPEN$ stands for trade openness, $GOVT$ stands for government consumption size as a percentage of GDP, $INVT$ stands for investment rate as a percentage of GDP, f_t is the time dummy while e_{it} is the error term.

Here, we expect that improvements in terms of trade (ToT) as well as increases in GDP per capita (GDPPC) and government consumption (GOV) lead to appreciation of the home currency.

The currency undervaluation is then calculated as presented in Equation 3,

$$Underval_{it} = \ln(RER)_{it} - \ln(\widehat{RER})_{it} \quad \text{eq3}$$

However, please note that when we use the RER estimation based on the Balassa-Samuelson effect, we superscript the undervaluation as $Underval_{it}^{BS}$. When we use the RER, estimation based on FEER, we superscript the undervaluation as $Underval_{it}^{FEER}$.

After addressing the issues in RER equilibrium determination, we move to focus on improving the growth regression equation. Here, too, we use 2 different augmented growth equations: one with $UNDerval^{BS}$ and one with $UNDerval^{FEER}$ so that the empirical specification for growth equation becomes:

$$\begin{aligned} Growth_{it} = & \delta_0 + \delta_1 \ln(RGDPPC)_{i,t-1} + \delta_2 Underval_{it}^{BS} \\ & + \delta_3 \ln(TOT)_{it} + \delta_4 OPEN_{it} + \delta_5 GOVT_{it} + \delta_6 INVT_{i,t-1} + \delta_7 \ln(INF)_{it} + \delta_8 \ln(LIFE)_{it} \\ & + \delta_9 Growth_{i,t-1} + f_t + f_i + e_{it} \end{aligned} \quad eq4$$

Where $RGDPPC_{i,t-1}$ is the lag value of real GDP per capita for country i to capture the effects of convergence. $Underval^{BS}$ is the currency undervaluation based on Balassa-Samuelson effects. TOT is the terms of trade, $OPEN$ is the trade openness, $GOVT$ is the government size (government consumption as a percentage of real GDP), $INVT$ is the investment rate as a percentage of real GDP, INF is the inflation rate, $LIFE$ is the life-expectancy (used for proxy for human capital development), $Growth_{i,t-1}$ is the lag values of GDP growth rate to capture the effects of dynamic panel estimation, f_t and f_i are the time and country-specific dummies while e_{it} is the error term.

Equation 4 is estimated again after $UNDerval^{BS}$ is replaced by $UNDerval^{FEER}$ so that we can identify if FEER-based undervaluation measurements improve the coefficient estimations of the growth equation.

Table 1 presents the theoretical expectations of the signs of our explanatory variables:

We expect that real GDP per capita ($RGDPPC$) has a negative effect on GDP growth rate ($Growth$) as it is standing to capture the effects of convergence. In line with the literature reviewed in this paper, we expect that real exchange rate undervaluation ($UNDerval$) will lead to economic growth. Hence the theoretically expected sign is positive. Terms of trade (TOT) is a ratio of a country's export price to import price. Thus, an improvement in the terms of trade is expected to boost the real GDP growth rates because it means better prices for export products and lower prices for imports. Trade openness ($OPEN$) is defined as a ratio of the sum of the exports and imports over GDP. High trade openness should then have a positive impact on economic growth rates since all the fundamental trade theories state that the larger the trade volume is, the bigger the benefits from trade are, and thus the richer the nations are. On the other hand, investment in physical capital ($INVT$) as well as in human capital – captured by Life-expectancy ($LIFE$) has a positive impact on economic growth rates. We expect that inflation (INF) have a negative impact on economic growth as it captures the effects of macroeconomic imbalances and uncertainty. Finally, the sign on government consumption ($GOVT$) is also negative as it stands to capture effects of disruptions to market mechanism.

Table 1. Theoretical expectations.

Explanatory Variable	Expected Sign	Explanatory Variable	Expected Sign
$RGDPPC$	-	$GOVT$	-
$UNDerval$	+	$INVT$	+
TOT	+	INF	-
$OPEN$	+	$LIFE$	+

5.2. Data

Our paper uses a panel data of 93² countries over the period 1990–2018.³ All data were obtained from the World Bank, World Development Indicators (WDI) 2019.⁴ In our regressions, we use the natural logarithm form of the following variables: lag of real GDP per capita (RGDPPCi,t-1), currency undervaluation (UNDerval), terms of trade (TOT), life expectancy (LIFE), and inflation rate (INF). For inflation rate, percentage values are added to one, before taking the natural logarithm form. This transformation is needed to avoid logs of possible negative numbers. All other variables are used as it is, that is without a natural logarithm form. These are the lag of GDP growth rate (Growthi,t-1), trade openness (OPEN), government size (GOVT) which is calculated as government consumption as a percentage of real GDP, and the lag of investment rate (INVi,t-1) which is also expressed as a percentage of real GDP.

5.3. Estimation technique

We reviewed several papers about the effect of the exchange rate on economic growth, with most of them suggesting that exchange rate misalignment implies the economic disequilibrium that is bad for growth, especially if the misalignment is in the form of overvaluation. We used a dynamic generalized method of moments (GMM) with a panel data of 93 countries. The GMM provides speedy and correct estimations of unknown parameters. Additionally, when extra samples are given or it includes higher-order moments, the variance of the estimator will decrease (see Lück and Wolf (2016)). Wooldridge (2001) mentions that GMM may be attractive due to the fact in many circumstances, regressions of unknown parameters are correct and reliable.

5.4. Causality

As Rodrik (2008) mentioned, the real exchange rate is an endogenous variable that means the variables do not capture a relationship that is truly causal. Also, we still have to worry about reverse causation and omitted variables bias, of course. The real exchange rate may respond to a variety of shocks besides policy. But it is difficult to think of accepted sources of bias that would cause the positive linkage between real exchange rate undervaluation and economic growth we have documented. To the extent that endogenous mechanisms are at work, they generally create a bias that works against these findings. Economic growth is expected to appreciate the exchange rate on standard Balassa-Samuelson grounds and Fundamental

²Algeria, Argentina, Armenia, Australia, Austria, Bahamas, Bahrain, Belgium, Belize, Bolivia, Brazil, Bulgaria, Burundi, Cameroon, Canada, Central African Republic, Chile, China, Colombia, Congo Dem. Rep., Costa Rica, Cote d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Dominica, Dominican Republic, Ecuador, Equatorial Guinea, Fiji, Finland, France, Gabon, Gambia, Georgia, Germany, Ghana, Greece, Grenada, Guyana, Hungary, Iceland, Iran, Ireland, Israel, Italy, Japan, Latvia, Lesotho, Luxembourg, Macedonia, Malawi, Malaysia, Malta, Mexico, Moldova, Morocco, Netherlands, New Zealand, Nicaragua, Norway, Pakistan, Papua New Guinea, Paraguay, Philippines, Poland, Portugal, Romania, Russian Federation, Samoa, Saudi Arabia, Sierra Leone, Singapore, Slovakia, Solomon Islands, South Africa, Spain, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Swaziland, Switzerland, Togo, Trinidad and Tobago, Tunisia, Uganda, Ukraine, United Kingdom, United States, Uruguay, Venezuela, and Zambia.

³We restricted our country selections with these countries because of available data for all variables.

⁴This data set included all necessary data for all variables over the period 1990–2018.

Equilibrium Exchange Rate model. Shocks that depreciate the real exchange rate tend to be shocks that are bad for growth on conventional grounds—a reversal in capital inflows or a terms of trade deterioration for example. Good news about the growth prospects of an economy are likely to attract capital inflows and appreciate the real exchange rate. So it is unlikely that our positive coefficient results from the effect of growth on the real exchange rate. If there is reverse causality, it would likely lead us to underestimate. Note that when we include the terms of trade in our basic specification, the results are unaffected. As expected, improvements in the terms of trade have a positive effect on growth, but the coefficient on UNDERVAL remains significant and essentially unchanged. We provide a further check on specification and endogeneity biases by presenting the results of dynamic panel estimation using GMM. These models use lagged values of regressors as instruments for right-hand side variables and also allow lagged endogenous variables as regressors in short panels (Arellano & Bond, 1991; Blundell & Bond, 1998; see Roodman, 2006 for an accessible user's guide). On the other hand, the estimation methods for panel data based on GMM are capable of effectively overcoming all the problems listed even if the researcher does not have good instrumental variables that are external to the model (Barros, Bergmann, Castro, & Silveira, 2020).

6. Empirical results

Let us now present our estimation results. Table 2 shows the result of the unit root test. According to Table 2, there is no unit root on variables at level except of RGDP.

The results of regression on RER equilibrium are presented in Table 3, followed by our growth regression results. First, we attempt to estimate the equilibrium level of RER according to two different methods; namely the RER based on (1) BS effect and (2) FEER model. Table 3 shows the result of these two models.

Under both Balassa-Samuelson-based and FEER-based RER equilibrium estimations, we find that there is a negative relationship between the real exchange rate and the real GDP per capita. These results are statistically significant at 5% significance level and are correct sign as they imply that when real GDP per capita increases, RER goes down indicating an appreciation of the home currency. This is theoretically in line with what is called the Balassa-Samuelson effect.

Table 2. Panel data unit root test (level data).

Variable	IPSTest Statistic(P-Value)	LLCTest Statistic(P-Value)	ADF-FisherTest Statistic(P-Value)
Growth	-16.2854(0.00)*	-15.6194(0.00)	622.193(0.00)
RGDPPC	7.3873(1.00)	0.2915(0.61)	61.169(1.00)
RER	-2.00318(0.02)	-2.79415(0.00)	269.497(0.00)
TOT	-7.38316(0.00)	-7.97885(0.00)	405.101(0.00)
OPEN	-0.9552(0.01)	-2.1426(0.01)	196.301(0.02)
GOVT	-6.1243(0.00)	-5.6963(0.00)	282.632(0.00)
INVT	-5.3586(0.00)	-3.5279(0.00)	302.463(0.00)
INF	-20.1296(0.00)	-22.8700(0.00)	693.592(0.00)
LIFE	-9.9254(0.00)	-24.0886(0.00)	586.411(0.00)

Source: Author's computation. *Null hypothesis is that there exists unit root.

More specifically in the BS-based approach, the coefficient estimate for the natural log of RGDPPC is (- 0.0736) implying that 1% increase RGDPPC causes 0.07% appreciation in local currency. The results are similar in the FEER model where 1% increase RGDPPC causes 0.08% appreciation in local currency. The estimate for RGDPPC according to Balassa-Samuelson approach is statistically significant at 1% significance level but RGDPPC is statistically significant at 5% according to the FEER model.

In FEER-based RER estimation in Equation 11, we added terms of trade (TOT), trade openness (OPEN), government size (GOVT), and investment (INVT) to Balassa-Samuelson equation. The results show that all four variables are statistically significant in estimating the equilibrium level of the RER.

More specifically, the coefficient estimates for TOT (Terms of trade) has a negative sign and is statistically significant at 5% significance level. The sign is of the theoretically correct sign because as the TOT improves (implying higher prices for the exports and lower prices for the imports) we expect that the home currency will appreciate which is represented by a decrease the real exchange rate. Indeed, the results show that if TOT increases by 1%, RER will decrease by 0.07%.

The theoretically expected signs of trade openness and investment are ambiguous. The theoretically expected sign for trade openness is ambiguous as the openness may arise from either increasing exports or increasing imports, which affects exchange rates differently. Similarly, the theoretically expected sign for investment is also ambiguous as it depends on the shares of tradable and non-tradable goods in the relevant spending basket. For example, if the share of non-tradable goods is higher, the real exchange rate will decrease, implying an appreciation of the home currency.

Our results show that the coefficient estimate for trade openness (OPEN) has a positive sign so that when OPEN increases by 1%, the home currency depreciates by 0.017% approximately. This result is statistically significant at 5% confidence interval. On the other hand, the coefficient estimate for Investment (INVT) has a negative sign so that when INVT increases by 1%, RER will decrease by 0.44%, implying an appreciation of the home currency accordingly. INVT is statistically significant at 1% significance level.

Table 3. Estimation of equilibrium level for RER.

Dependent variable: real exchange rate		
	Balassa–Samuelson(BS)	Fundamental Equilibrium Exchange Rate (FEER)
Ln(RGDPPC)	-0.07365 (-2.537556)*	-0.08706 (-2.106156)**
Ln(TOT)		-0.07625 (2.353947)**
OPEN		0.01750 (2.380280)**
GOVT		0.0293 (2.13193)**
INVT		-0.44040 (-8.017593)*

Source: Author's computation. Note 1: the number in parenthesis are t-statistics. Note 2: (*), (**) and (***) indicate that the estimated parameters are significant at the 1%, 5%, and 10% significance level respectively.

Finally, the results for the coefficient estimate for the Government Size (GOVT) show that it has a positive sign and this is statistically significantly so at 5% significance level. Unfortunately, this is against our theoretical expectation. It is well known that the majority of government consumption goes to non-tradable local services, raising the relative price of non-tradables and thus causing the appreciation of the home currency. This odd result is beyond the focus of this thesis but nevertheless shows that there might be a room for improvement in estimating the equilibrium level for RERs.

After estimation of RER equilibrium via two different methods, we turn our focus on growth equation. Table 4 presents three different regression results: (1) according to initial Rodrik model, (2) augmented growth estimation where RER is measured via Balassa-Samuelson-based Rodrik approach, and (3) augmented growth estimation where RER is measured via FEER-based approach.

First of all, we want to focus on the first column which shows the initial Rodrik's growth model. The lag of real GDP per capita (RGDPPC) has a negative effect on economic growth. This is a theoretically expected sign in line with the convergence theorem. More specifically, if the real GDP per capita in the earlier period is 1% higher, this leads to the GDP growth rate to decrease by 0.66% approximately. Also, the estimate for the RGDPPC is statistically significant at 1% significant level.

UNDERVAL^{BS} (undervaluation of home currency) is also of correct sign according to Rodrik model and statistically significant at 1% significance level. 1% increase of UNDERVAL^{BS} leads to boost the GDP growth rate by 0.02%.

The second column of Table 4 shows the results from the improved Rodrik model where the growth equation is augmented with further explanatory variables as presented before. Similar to the first column, RGDPPC and UNDERVAL^{BS} are a correct sign and statistically significant at 1% significance level. The estimate for RGDPPC is -0.7974 with a t-statistics of -50.03 which implies statistical significance at 1%. The coefficient estimate implies that if real GDP per capita in the earlier period is 1% higher, this leads to 0.79% decrease in GDP growth rate.

Table 4. Estimating the growth models.

Dependent Variable: Growth (RGDP Growth Rate)			
	Initial Rodrik Growth model	Augmented Growth (BS-approach)	Augmented Growth (FEER-approach)
Lag of growth		0.066378 (42.59829)*	0.056282 (26.98620)*
Ln (RGDPPC)	-0.65915 (-271.3714)*	-0.79738 (-50.02754)*	-0.7680357 (-39.25344)*
Ln (Underval ^{BS})	0.022504 (49.61075)*	0.022007 (6.628207)*	
Ln (Underval ^{FEER})			0.067886 (14.50232)*
Ln (TOT)		0.409500 (5.330905)*	0.278745 (2.678558)*
OPEN		0.051521 (48.16377)*	0.052211 (45.11895)*
GOVT		-0.758011 (-44.63065)*	-0.837546 (-32.30611)*
INVT		0.154141 (124.6659)*	0.147419 (122.3304)*
Ln (INF)		-0.11526 (-40.70463)*	-0.11125 (-42.58425)*
Ln (LIFE)		0.03753 (3.991404)*	0.051097 (3.704361)*
Time Dummies	Yes	Yes	Yes
Country Dummies	Yes	Yes	Yes

Source: Author's computation. Note 1: the number in parenthesis are t-statistics. Note 2: (*), (**) and (***) indicate that the estimated parameters are significant at the 1%, 5%, and 10% significance level respectively.

UNDERVAL^{BS} estimate is 0.022 with a t-statistics of 6.63 which implies statistical significance at 1%. The coefficient estimate implies that if the currency undervaluation increases by 1%, this leads to 0.022% increase of GDP growth rate.

Terms of trade (TOT) is a ratio of a country's export price to import price. Thus, an improvement in the terms of trade helps to boost the real GDP growth rates; in the sense that higher TOT means better prices for export products and lower prices for imports. Our results show that TOT has – as theoretically expected- a positive relationship with the GDP growth rate. TOT estimate is 0.41 with a t-statistics of 5.33, which implies that the coefficient estimate is statistically significant at 1% significance level. Moreover, it means that 1% increase in TOT will improve the GDP growth rate by 0.41%.

Trade openness (OPEN) is defined as a ratio of sum of the exports and imports over GDP. High trade openness should then have a positive impact on economic growth rates since all the fundamental trade theories states that the bigger is the trade, the bigger are the benefits from trade and the richer are the nations. According to Table 4 results in column two, the coefficient estimates for OPEN is 0.051 with t-statistics 48.16. In other words, if OPEN increases by 1%, the GDP growth rate will increase by 0.05% and this result is statistically significant at 1% confidence interval.

The results in Column 2 in Table 4 also show that GOVT and INF have negative impact on economic growth and this is statistically significant at 1% significance level, probably implying the disturbances caused by macro-economic mismanagements. On the other hand, investment in physical capital (INVT) as well as in human capital – captured by Life-expectancy (LIFE) have a positive impact on economic growth rates. These are statistically significant so at 1% significance level.

The results in Column 3 in Table 4 show very similar results for all explanatory variables. Therefore, they will not be further explained. However, we want to note that the estimation in Column 3 uses a currency undervaluation based on FEER model. The results show that currency undervaluation – according to both the BS-approach and FEER-model – promotes growth, but the coefficient estimate for $Underval_{it}^{FEER}$ is bigger and more significant than $Underval_{it}^{BS}$.

Finally, we attempt to check the robustness of the results in Table 4 by augmenting the model by adding two lags of currency undervaluation on both type of regressions (that is the one where RER equilibrium is measured according to the BS-approach and the one where RER equilibrium is measured according to the FEER-approach. This allows us to observe the effects of currency undervaluation on economic growth in line with the method used by Razmi et al. (2012).

Table 5 shows the results of the regressions where the growth is estimated by the inclusion of the lag values of currency undervaluation. For all explanatory variables, the results are statistically significant and very similar to the results presented in Table 4. As for the currency undervaluation and its lags, the results show that undervaluation and its first lag have a positive and significant effect on growth for both under the BS-approach and the FEER-approach. On the other hand, the second lag of the undervaluation is statistically insignificant in explaining the economic growth under both approaches.

Table 5. Estimating the growth models (lags of undervaluation included).

Dependent variable: Growth (Real GDP Growth Rate)		
	Balassa–Samuelson (BS)	Fundamental equilibrium exchange rate (FEER)
Lag of growth	0.080532 (3.200852)*	0.066378 (2.578059)*
Ln (RGDPPC)	−0.567079 (−8.447694)*	−0.704878 (−11.75093)*
Ln (underval ^{BS})	0.049007 (6.878234)*	
Ln (underval ^{BS} , first lag)	0.045055 (3.161220)*	
Ln (underval ^{BS} , second lag)	−0.010895 (−0.875955)	
Ln (underval ^{FEER})		0.05312030 (1.96230)**
Ln (underval ^{FEER} , first lag)		0.068762 (2.507721)**
Ln (underval ^{FEER} , second lag)		−0.064953 (−1.458096)
Ln (TOT)	0.335980 (1.985105)**	0.318136 (1.987476)**
OPEN	0.052030 (5.806908)*	0.054152 (5.873012)*
GOVT	−0.806478 (−10.55525)*	−0.857318 (−10.82669)*
INVT	0.173679 (8.021967)*	0.162230 (6.438624)*
Ln (INF)	−0.092598 (−6.877168)*	−0.09125293 (−6.584923)*
Ln (LIFE)	0.060348 (2.963552)*	0.094059 (4.302232)*
Time Dummies	Yes	Yes
Country Dummies	Yes	Yes

Source: Author's computation. Note 1: the number in parenthesis are t-statistics. Note 2: (*), (**) and (***) indicate that the estimated parameters are significant at the 1%, 5%, and 10% significance level respectively.

7. Conclusion

The real exchange rate is one of the most important variables in open macro-economics. In international economics, it is often considered as a factor affecting the international competitiveness. However, the effects the real exchange rate has on competitiveness, export performance and on GDP growth rate are complex, and thus need a thorough investigation. Since Rodrik (2008), there has been an ever-growing literature looking at the impact of RER on economic growth. This paper aimed to contribute to this literature by employing better estimation techniques (GMM) and by inclusion of lag values of RER-undervaluation measurements.

More specifically we first estimate two different measurements of currency undervaluation: One is based on Rodrik's Balassa-Samuelson-based undervaluation and the other is Fundamental Equilibrium Exchange Rate (FEER)-based undervaluation. Then we use these measurements in a growth regression. The differences between these two undervaluation measurements are due to the “fundamentals” that drive equilibrium exchange rates that have a direct effect on growth.

Our results indicate that RER-undervaluation measurements can be improved by the inclusion of FEER-based other fundamental variables. Our growth regressions produce coefficient estimates that are mostly statistically significant and of correct sign. Moreover, the effects of both types of undervaluation on economic growth turn out to be statistically significant at 5% significance level. They are also with signs which are in line with our theoretical expectations and the literature in the field. Finally, inclusion of first lag values of RER-undervaluation do improve the models as they turn out to be statistically significant also.

Thus, our study confirms that undervaluation is also good for growth, confirming the findings of Rodrik (2008) and the most of subsequent literature. We conclude that it is better to identify undervaluation using FEER rather than BS, and that to include the lag of undervaluation.

Finally, understanding the role of the undervaluation for growth will probably require more than the growth-regression model employed here, and it can be recommended to look at more evidences to see which channels are operating better as highlighted by Rapetti (2020). Three theoretical transmission channels mentioned by Rapetti were the “Washington Consensus” channel, the “foreign saving” channel, and the “tradable-led growth” channel. Indeed we believe that future research in the field will focus on investigating the effects of these channels.

Notes on contributors

Mehdi Seraj is an assistant professor of economics at Near East University in North Cyprus. His research interests include the Economic growth, Exchange rate, Economic development, and Energy economics.

Çagay Coskuner is an associate professor of economics at Eastern Mediterranean University in North Cyprus. His research interests include the Real exchange rates, Technology diffusion, Growth and Solow Residual, Income Inequality

ORCID

Mehdi Seraj  <http://orcid.org/0000-0002-4746-6970>

References

- Abida, Z. (2011). Real exchange rate misalignment and economic growth: An empirical study for the Maghreb countries. *Zagreb International Review of Economics & Business*, 14(2), 87–105.
- Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies*, 58(2), 277–297.
- Balassa, B. (1970). Growth strategies in semi-industrial countries. *The Quarterly Journal of Economics*, 84(1), 24–47.
- Barros, L. A., Bergmann, D. R., Castro, F. H., & Silveira, A. D. M. D. (2020). Endogeneity in panel data regressions: Methodological guidance for corporate finance researchers. *Revista Brasileira De Gestão De Negócios*, 22, 437–461.
- Berg, A., & Miao, Y. (2010). The real exchange rate and growth revisited: The Washington consensus strikes back? Working paper, Research Department and African Department, IMF.
- Berka, M., & Devereux, M. B. (2010). *What determines European real exchange rates?* (No. w15753). National Bureau of Economic Research.
- Berka, M., Devereux, M. B., & Engel, C. (2014). Real exchange rates and sectoral productivity in the eurozone (No. w20510). National Bureau of Economic Research.
- Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87(1), 115–143.
- Cottani, J. A., Cavallo, D. F., & Khan, M. S. (1990). Real exchange rate behavior and economic performance in LDCs. *Economic Development and Cultural Change*, 39(1), 61–76.
- Devereux, M. B., Engel, C., & Tille, C. (2003). Exchange rate pass-through and the welfare effects of the euro. *International Economic Review*, 44(1), 223–242.
- Dollar, D. (1992). Outward-oriented developing economies really do grow more rapidly: Evidence from 95 LDCs, 1976–1985. *Journal of Economic Development and Cultural Change*, 40(3), 523–544.
- Easterly, W. (2003). *National policies and economic growth: A reappraisal*. New York: Center for Global Development, New York University.

- Eichengreen, B. (2008). *The real exchange rate and economic growth*. Berkeley: University of California.
- Elbadawi, A., Kaltani, L., & Soto, R. (2012). Aid, real exchange rate misalignment, and economic growth in Sub-Saharan Africa. *Journal of World Development*, 40(4), 681–700.
- Ghura, D., & Grennes, T. J. (1993). The real exchange rate and macroeconomic performance in Sub-Saharan Africa. *Journal of development economics*, 42(1), 155–174
- Gluzmann, P. A., Levy-Yeyati, E., & Sturzenegger, F. (2012). Exchange rate undervaluation and economic growth: Diaz Alejandro (1965) revisited. *Journal of Economics Letters*, 117(3), 666–672.
- Habib, M. M., Mileva, E., & Stracca, L. (2017). The real exchange rate and economic growth: Revisiting the case using external instruments. *Journal of International Money and Finance*, 73, 386–398.
- Hinkle, L. E., & Monteil, P. J. (1999). *Exchange rate misalignment: Concepts and measurement for developing countries*. Oxford university Press
- Levy-Yeyati, E., & Sturzenegger, F. (2007). *Fear of appreciation*. Policy Research Working Paper 4387, World Bank.
- Lück, A., & Wolf, V. (2016). Generalized method of moments for estimating parameters of stochastic reaction networks. *BMC Systems Biology*, 10(1), 98.
- Montiel, P. J., & Servén, L. (2008). *Real exchange rates, saving and growth: is there a link?* Policy research working paper 4636, World Bank.
- Rapetti, M. (2020). The real exchange rate and economic growth: A survey. *Journal of Globalization and Development*, 11(2). doi:10.1515/jgd-2019-0024
- Razmi, A., Rapetti, M., & Skott, P. (2012). The real exchange rate and economic development. *Structural Change and Economic Dynamics*, 23(2), 151–169.
- Rodrik, D. (2008). The real exchange rate and economic growth. *Brookings Papers on Economic Activity*, 39(Fall 2008), 365–439.
- Roodman, D. (2006). How to do xtabond2: An introduction to ‘difference’ and ‘system’. In *GMM in STATA*, Center for Global Development Working Paper No. 103.
- Sachs, J., & Warner, A. (1995). Economic reform and the process of global integration. *Brookings Papers on Economic Activity*, 1, 1–118.
- Tharakan, J. (1999). Hoteling and international trade. *Journal of European Economics*, 2, 407–424. CEDIN, Technical University of Lisbon.
- Vieira, F. V., Holland, M., Gomes da Silva, C., & Bottecchia, L. C. (2013). Growth and exchange rate volatility: A panel data analysis. *Journal of Applied Economics*, 45(26), 3733–3741.
- Williamson, J. (1994). *Estimating equilibrium exchange rates*. Washington: Peterson Institute Press.
- Williamson, O. E. (1990). A comparison of alternative approaches to economic organization. *Journal of Institutional and Theoretical Economics* (JITE)/Zeitschrift für die gesamte Staatswissenschaft, 61–71
- Wooldridge, J. M. (2001). Applications of generalized method of moments estimation. *Journal of Economic Perspectives*, 15(4), 87–100.
- Ybrayev, Z. (2021). Real exchange rate management and economic growth: Export performance in Kazakhstan, 2009–2019. *International Review of Applied Economics*, 35(1), 64–90.
- Zhang, Q. (2017). The Balassa–Samuelson relationship: Services, manufacturing and product quality. *Journal of International Economics*, 106, 55–82.